

What is claimed is:

1. A bipolar transistor comprising:
a first collector region of a first conductive type having high impurity concentration;
a second collector region of a first conductive type having high impurity concentration,
the second collection region formed on the first collector region;
a base region of a second conductive type being formed a predetermined portion of
the second collector region; and
an emitter region of a first conductive type being formed in the base region;
wherein a third collector region is further formed at an interface between the base
region and the second collector region, the third collector region whose impurity
concentration is higher than that of the second collector region.
2. The bipolar transistor of claim 1, wherein the impurity concentration of the
third collector region gradually decreases, as the third collector region more closely
approaches an interface between the third collector region and the base region to the second
collector region.
3. The bipolar transistor of claim 1, wherein the third collector region has lower
impurity concentration than the first collector region.
4. The bipolar transistor of claim 1, wherein the first collector region has
impurity concentration from $10^{14}/\text{cm}^3$ to $10^{20}/\text{cm}^3$.
5. The bipolar transistor of claim 1, wherein the second collector region has
impurity concentration from $10^{13}/\text{cm}^3$ to $10^{16}/\text{cm}^3$.
6. The bipolar transistor of claim 1, wherein the third collector region has
impurity concentration from $10^{14}/\text{cm}^3$ to $10^{17}/\text{cm}^3$.
7. The bipolar transistor of claim 1, further comprising:
a base electrode being formed in a predetermined portion of the base region so as to
contact the base region;
an emitter region being formed in a predetermined portion of the emitter region so as
to contact the emitter region; and

a collector electrode being formed at the bottom of the first collector region.

8. The bipolar transistor of claim 1, wherein the impurity concentrations of the base region, the emitter region, and the first collector region gradually increase toward an interface between the base region and the base electrode, an interface between the emitter region and the emitter electrode, and an interface between the collector region and the collector electrode, respectively.

9. The bipolar transistor of claim 1, wherein the first conductive type is an *n* type and the second conductive type is a *p* type.

10. The bipolar transistor of claim 9, wherein impurities of the first conductive type are phosphorous ions and impurities of the second conductive type are boron ions.

11. A method of manufacturing a bipolar transistor, comprising:
forming a high-concentration first collector region of a first conductive type at the bottom of a semiconductor substrate that is doped with low-concentration impurities of a first conductive type, thereby defining a second collector region on the semiconductor substrate on the first collector region;
implanting at least one of first conductive impurities for a third collector region and second conductive impurities for a base region into the second collector region;
activating the first conductive impurities for the third collector region and the second conductive impurities for the base region, thereby forming the base region and the third collector region below the base region; and
forming an emitter region in the base region,
wherein the third collector region has higher impurity concentration than the second collector region.

12. The method of claim 11, wherein the first conductive impurities are ion-implanted into the third collector region, so that the third collector region has lower impurity concentration than the first collector region.

13. The method of claim 11, wherein the first collector region and the emitter region are obtained by ion-implanting corresponding impurities into the first collector region and the emitter region and activating the implanted impurities, respectively.

14. The method of claim 11, after forming the emitter region, further comprising:
depositing an insulating layer on the semiconductor substrate on which the base region and the emitter region are formed;
partially etching the insulating layer to expose predetermined portions of the base region and the emitter region;
forming a base electrode and an emitter electrode on the exposed portions of the base region and the emitter region; and
forming a collector electrode at the first collector region.

15. The method of claim 11, wherein the first conductive type is an *n* type and the second conductive type is a *p* type.

16. The method of claim 11, wherein the first conductive impurities are phosphorous ions and the second conductive impurities are boron ions.

17. A bipolar transistor, comprising:
a first collector region having a first concentration of a first conductive type;
a second collector region having a second concentration of a first conductive type and formed on the first collector region;
a third collector region having a third concentration of a first conductive type and formed on the second collector region, wherein the third concentration is higher than the second concentration;
a base region formed on a portion of the third collector region; and
an emitter region formed on a portion of the base region.

18. The bipolar transistor of claim 17, wherein the third concentration decreases from the base region to the second collector region.

19. The bipolar transistor of claim 17, wherein the third concentration is lower than the first concentration.

20. The bipolar transistor of claim 17, further comprising:
- a base electrode contacting a portion of the base region;
 - an emitter electrode contacting a portion of the emitter region; and
 - a collector electrode contacting a portion of the first collector region.
21. The bipolar transistor of claim 17, wherein the first conductive type is an *n* type and the second conductive type is a *p* type.
22. A collector for a bipolar transistor, comprising:
- a first collector region having a first impurity concentration of a first conductive type;
 - a second collector region having a second impurity concentration of a first conductive type and formed on the first collector region; and
 - a third collector region having a third impurity concentration of a first conductive type and formed on the second collector region, wherein the third impurity concentration is higher than the second impurity concentration.
23. The bipolar transistor of claim 22, wherein the third concentration decreases from the base region to the second collector region.
24. A method for making a bipolar transistor, the method comprising:
- providing a first collector region having a first concentration of a first conductive type;
 - providing a second collector region having a second concentration of a first conductive type and formed on the first collector region;
 - providing a third collector region having a third concentration of a first conductive type and formed on the second collector region, wherein the third concentration is higher than the second concentration;
 - providing a base region formed on a portion of the third collector region; and
 - providing an emitter region formed on a portion of the base region.
25. The method of claim 24, wherein the third concentration decreases from the base region to the second collector region.

26. A method for making a collector of bipolar transistor, the method comprising:
providing a first collector region having a first concentration of a first conductive type;

providing a second collector region having a second concentration of a first conductive type and formed on the first collector region; and

providing a third collector region having a third concentration of a first conductive type and formed on the second collector region, wherein the third concentration is higher than the second concentration.